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A Pipe Separator with Improved Separation

The present invention concerns a pipe separator for separation of fluids, for example separation of oil, gas and water in connection with the extraction and production of oil and gas from formations under the sea bed, comprising an extended, tubular separator body that has a diameter at the inlet and outlet ends that is mainly equivalent to the diameter of the transport pipe to which the pipe separator is connected, a cyclone arranged upstream of the separator body for separation of any gas present and an electrostatic coalescer arranged in connection with the pipe separator.

The applicant's own Norwegian patent application nos. 19994244, 20015048, 20016216, 20020619 and 20023919 describe prior art pipe separators for the separation of oil, water and/or gas downhole, on the sea bed or on the surface, on a platform or similar. In particular, patent application no. 20023919 shows a solution in which a separate, compact electrostatic coalescer is used in connection with the pipe separator. The oil flow from the pipe separator is passed to the coalescer downstream of the pipe separator and subsequently to a further oil/water separator that removes the remaining water after separation in the pipe separator. This prior art solution is particularly designed for, but not limited to, medium heavy oils with water removal from the oil phase to 0.5% water, using a cyclone or other type of gas/liquid separator to remove gas before the pipe separator.

The solution requires an additional separator, which is complicated and expensive, and the coalescer itself, which is of a vertical type, cannot be reamed or pigged (cleaned) in the conventional manner. This also represents a considerable disadvantage of the prior art solution.

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The present invention represents a considerably simplified separation solution in which the above disadvantages are avoided. The present invention is characterised in that the electrostatic coalescer is incorporated in and constitutes an integrated part of the separator body, as stated in the attached claim 1.

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The dependent claims 2-5 indicate the advantageous features of the present invention.

The present invention will be described in further detail in the following with reference to the attached drawings, where:

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Fig. 1 shows an elementary sketch of a pipe separator in accordance with the present invention.

Fig. 2 shows an enlarged part of the separator shown in Fig. 1 in the area of the coalescer in a cross-section a) and a longitudinal section b).

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The solution shown in Fig. 1 comprises a tubular separator body 1, a liquid seal 6, arranged downstream of the separator body, for the water phase in the fluid (oil/water) that flows through the separator, a drainage device 7 with an outlet 8 for the separated water, a pig battery 5, arranged upstream of the separator body in connection with a well head 9, a connection pipe 10 that connects the well head to the separator body 1 and a transport pipe 11 for oil downstream of the separator body. The special feature of the present invention is that a coalescer 4 is incorporated in the separator body 1 as an integrated unit. The coalescer is expediently arranged at a distance of between $1/3$ and $1/2$ of the length of the separator body from the inlet of the separator body. However, its location is not limited to this. Fig. 2 shows in large scale, in cross-section and longitudinal section, the part of the separator body in which the coalescer is incorporated. As the figure

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shows, the coalescer comprises an upper electrode 12 and a lower electrode 13 that are enclosed in expediently insulating material in the wall 14 of the separator body. The electrodes are designed to have applied to them (not shown in further detail) an expedient voltage "V" (AC voltage) to create an electric field that contributes to increasing the separation of water from the fluid (oil and water) flowing through the separator. As Fig. 1 shows, a cyclone 3 (or another expedient gas/liquid separator) is arranged upstream of the separator body 1 to remove any gas from the fluid that is produced in the wells 9. The intention of removing the gas is to avoid it reducing the effect of the coalescer as the gas is a poor electrical conductor. Another intention is to prevent the formation of plug flow in the separator.

The method of operation of the separator solution in accordance with the present invention is otherwise as follows:

Fluid, i.e. gas, oil and water, that is produced is passed first to the cyclone 3, where the majority of gas is removed and passed on in a separate pipe 9, possibly being reintroduced into the transport pipe 11 after the separator.

The liquid phase, which may contain small amounts of gas, is introduced into the separator body 1. Free water will separate quickly and form a water phase under the oil phase. The gas bubbles will collect in the top of the separator pipe and, depending on their concentration, form a free gas phase. When coarse separation has been completed (i.e. the water phase on the bottom, the oil phase with small oil drops in the centre and possibly a thin gas phase on the top), the fluid will pass into the integrated coalescer 4.

In the coalescer 4, a voltage drop will be created mainly over the oil zone because the water zone conducts current and the gas zone also has good conduction properties.

The voltage drop over the oil zone (alternating current) produces increased drop coalescence and destabilises the oil/water interface. The water drops grow in size and will separate quickly after the fluid has entered the pipe separator element 1 again.

In the separator element downstream of the coalescer, the coalesced water drops will be separated out and collected in the collection unit 7, where the water is drained out via the pipe 8. The oil will flow on past the water seal 6 to the transport pipe 11.

The present invention as it is defined in the claims is not limited to the example shown and described above. The separator may be provided with two or more coalescers 4 arranged in series in the separator element 1. This may be particularly relevant for oils that are difficult to separate such as heavier oils.

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The cyclone 3 may also be located in places other than the well head as shown in Fig. 1. It has proved expedient for the cyclone to be located in connection with equipment that causes high shear for the fluid as this produces good separation conditions. However, it may also be relevant to locate the cyclone in close proximity to the separator's inlet in situations in which the separator is located far from the well head.

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